Magnetically interacting Fe_3O_4-nanoparticles within porous silicon

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Mesoporous silicon is used as matrix for infiltration of Fe_3O_4-nanoparticles. The structure and magnetic behaviour of such composites are investigated and a correlation between the morphology of the nanocomposite (structure of the matrices, size and distribution of Fe_3O_4-particles) and the magnetic properties of the system is figured out. This system shows a superparamagnetic (SPM) behaviour at room temperature and becomes ferromagnetic (FM) at lower temperatures. The transition temperature between SPM and a blocked state depends on the particle size, their coating and on their magnetic interactions. The blocking temperature of the composite is tunable and changes due to the variation of dipolar coupling of the Fe_3O_4-particles. To gain deeper information about the stoichiometric homogeneity and spatial distribution, dual electron energy loss spectroscopy is employed. This method provides areal and volumetric densities of each element over the investigated area. Electron tomography is utilized whereas from reconstructions various parameters of the composite morphology can be obtained (size and spatial distribution of the particles and dependence of the local curvature of the pore walls with respect to the preferred docking site). These results together with the magnetic data lead to a more detailed knowledge of the Fe_3O_4/silicon nanocomposite system.

9.7 cm

13.4 cm

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